SIEMENS

POLYMOBIL III

SP

Function description X038I

Wiring index E
from Serial no. 3000

English

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Generator principle

The POLYMOBIL III makes use of high-frequency inverter technology.

An 8-bit microcontroller on board D 910 controls the entire system. The control circuits, operating switches and operating panel indicators are connected to this controller.

Line connection

The POLYMOBIL III should be connected to a grounded outlet.
The line voltage must be either 110 V or 230 V.

When switching the unit on at board D 910 (3 / 1), the line voltage is automatically switched over via the LU contactor (3 / 3) at transformer T1. The switch-over voltage is 160 V.

Switching power supply M6 (3 / 6) generates the internal supply voltages for the electronic components.

By actuating the line voltage switch on the operating console on D 910 (3 / 1), the HR relay on board D 920 is switched on. The DC intermediate circuit (3 / 7) is charged via resistor R 5 (3 / 1).

As soon as initialization has ended, the US contactor (3 / 5) energizes and shorts out charging resistor R5.

Following successful completion of the self-test, the default values:

60 kV and 10 mAs are displayed.

The Polymobil III is now ready to operate.

Due to high-frequency oscillation generated in the inverter, an integrated EMC line filter Z1 (3 / 1) has been connected to suppress interference signals.

DC intermediate circuit

The line voltage is rectified by rectifier V1 (3 / 7) and supplied to the charging capacitors C1 and C2 in the intermediate circuit on board D 111. Parallel resistors R1 and R2 effect a symmetrical voltage distribution across the charging capacitors. They also discharge the intermediate circuit after switching the system off.

The intermediate circuit supplies voltage to the main inverter.

At 230 V line voltage, V1 (3 / 7) acts as a standard rectifier and the LU contactor is open. At 100 V line voltage, the LU contactor (3 / 6) closes and rectifier V1 in combination with intermediate circuit capacitors C1 and C2 acts as a voltage doubling circuit.

For safety reasons, intermediate circuit capacitors C1 and C2 automatically discharge via the auxiliary contact 21-22 (3 / 7) of the US contactor and resistor R3 after the Polymobil has been switched off.

The intermediate circuit voltage is monitored by microcontroller J15 on board D 910.

Main inverter

The main inverter generates high frequency energy packets for the high-voltage transformer. The microcontroller regulates high voltage during exposure via the control frequency.

By triggering two "Isolated Gate Bipolar Transistors", called IGBT's, across a bridge diagonal, a charge voltage flows through the primary serial circuit L2, C4 and the high voltage transformer in the X-ray tube single tank generator (4 / 2).

Subsequently, the charge voltage across serial capacitor C4 is higher than the intermediate circuit voltage. This higher capacitor voltage forces a reverse voltage impulse across the antiparallel transistor-diodes and the intermediate circuit. The amplitude of the reverse voltage impulse is always smaller than that of the charge voltage impulse.

One cycle of oscillation is now complete and another one can be transmitted in the opposite direction.

Two bridge diagonals are always required in an inverter, since otherwise the magnetic flow in the iron core of the high-voltage transformer would reach a saturation state.

Additional energy packets can be transmitted by alternating control of the bridge diagonals. The maximum inverter frequency is 10 kHz.

During the exposure, the current IS (4 / 3) is measured on board D 920 and used to synchronize the control pulses (4 / 5).

Monitoring the inverter

A possible bridge short circuit is detected by monitoring the collector-emitter voltage Uce of every IGBT and, if necessary, by blocking the inverter. The microcontroller then indicates an error message:

ERR 11	Inverter short circuit

Refer to chapter 3 in the service instructions.

Remarks: If the corrugated hose between the switch module and the X-ray tube single tank is not connected, the Polymobil III cannot be switched on.

Testing the inverter

If jumper S1 on board D 920 (92 B / 7) is removed, the inverter can be operated without high voltage.

The exposure is interrupted after 15 ms. An error message is displayed:

ERR 14	kV-ACT < kV-NOM

X-ray tube single tank generator

The main inverter feeds the primary winding of the high-voltage transformer (5 / 1). The secondary winding is connected to two high voltage cascades. These supply the stationary anode with high voltage.

The oil pressure switch S1 (5 / 1) in the tube housing responds if the single tank generator becomes overheated during high use. The following error message is displayed:

ERR 9	Oil pressure in single tank too high

Actual value acquisition

The momentary tube voltage is acquired via a frequency-compensated voltage divider (10 000 : 1). This kV ACT value can be measured on board D 910 (5 / 2) via an oscilloscope.

The tube current is acquired via resistor R2 on board D 1. It can be measured via an oscilloscope at board D 910. In addition, the mAs jack is located on board D 1 (5 / 4).

Overvoltage arrester U1 protects the filament circuit during no-load operation. The V1 suppressor diode protects the filament circuit from over voltage. Suppressor diode V2 protects the mA ACT circuit during no-load operation.

The kV measurement circuit is protected by overvoltage arrester U2.

kV regulation

The analog kV NOM value (6 / 3) results from pulse width modulation and can be measured on the oscilloscope on board D 910.

KV NOM and kV ACT are compared and forwarded to PI regulator J33. The output signal of this regulator is forwarded to a voltage frequency converter. The output frequency can be measured on the oscilloscope at measurement point REG (6 / 1). The pulse patterns for the inverter diagonals are subsequently generated.

The current is measured in the inverter and synchronized with the pulse patterns. The current can be measured on the oscilloscope on board D 920, measurement point IS (4 / 3).

The microcontroller controls the U/F converter J21 (6 / 1). Refer to measurement point TRIG on board D 910 (6 / 4). Exposure is also switched on and off via this component.

kV monitoring

The kV ACT value is continuously being compared with the maximum acceptable kV limit values in the threshold components J29 (6 / 2). The inverter is immediately blocked by switching off the SS relay (6 / 5) when the kV limit value is exceeded.

The inverter is disabled in response to the following errors:

Bridge short circuit	ERR 11	
kV-MAX	ERR 12	100 kV + 10 %
I-MAX	ERR 13	50 mA + 10 %
I-filament-MAX	ERR 13	5 A + 20 %
kV-ACT < kV-NOM	ERR 14	kV-NOM - 25 %

Filament regulation

The analog nominal value of the filament circuit or tube current is generated by the microcontroller J 15 via pulse width modulation and can be measured on the oscilloscope on board D 910 at measurement points :

IHS (7 / 3)	Filament current
IRS (7 / 3)	Tube current

The actual value of the filament current can be measured across resistor R 58 and monitored by the microcontroller.

I-FIL-NOM and I-FIL-ACT are linked to each other and forwarded to the PI regulator J 32. The output signal of this regulator is forwarded to a voltage frequency converter. This output frequency can be measured via an oscilloscope at measurement point CAL (7 / 2) on board D 910. This impulse sequence controls switching transistor V 32 and also the current through the filament.

The actual tube current IR is used for regulation during the exposure.

If the voltage in the intermediate circuit is lower than 260 V=, the tube current is automatically reduced by amplifier J 18 on board D 910. The intermediate circuit voltage can be measured at measurement point VL (7 / 5).

Filament monitoring

If the filament current IH or the tube current IR exceed the maximum acceptable value, the threshold components J 29 on board D 910 will respond.
The generator is disabled and the following error codes will be displayed on the control panel:

ERR 13	I-TU-MAX + 10 %
ERR 13	I-FIL-MAX + 20 %

mAs counter

The tube current acquired on board D 1 (7 / 3) is forwarded to the voltage frequency converter J 26 (7 / 4) on board D 910. This converter generates a proportional frequency at a ratio of:

10 mA => 1 V corresponds to 3.2 kHz.

The output pulses can be measured on the oscilloscope at measurement point F1 on board D 910 (7 / 4). The pulses are digitally integrated in the microcontroller and the exposure is ended when the mAs NOMINAL value is attained.

Microcontroller unit

Central monitoring and control is processed via an 8-bit microcontroller (8 / 3).The controller communicates via a bus system with:

J8	EPROM, contains the firmware,
J11	RAM, not used,
J19	Display-Controller.

High voltage, filament and tube current are controlled via parallel port inputs and outputs.

In addition, several interrupt inputs and an internal watchdog are available via the microcontroller. The watchdog monitors the software functions in POLYMOBIL III. There is no external signal or display for the watchdog on board D 915.

The component J 3 on board D 910 monitors the voltage supply Vref = +5 V (6 / 3). If the voltage drops below 4 V , a RESET is automatically triggered.

Exposure circuit

Preparation:

When selecting preparation -ZB- on exposure release switch S 27 (8 / 4), an interrupt is generated in the microcontroller.

If the microcontroller is not blocked by any error message, the tube filament will be heated up in preparation for exposure.

The display controller J 19 (91 A / 3) triggers LED V 13 - ZB (91 A /7) on board D 910.

The exposure is released after a preparation time of 1.9 seconds has elapsed.

Exposure release:

When the main contact - HK- is pressed on the exposure release switch S 27 (8 / 4), the main inverter, measurement point: TRIG (6 / 4), is released and the exposure begins.

Exposure shutoff:

When the mAs counter reaches the mAs NOMINAL value, the exposure is ended by the microcontroller.

Interrupting exposure

An exposure can be interrupted by one of the following events:

- The time limit (T-Limit) is reached before the mAs counter reaches the NOMINAL value. A safety timer ends the exposure and the following error message appears:

  ERR 17 maximum exposure time.

  >> T-Limit = 2 x theoretical exposure time + 100 ms <<

- kV-ACT > kV-MAX. As soon as this error occurs, the inverter is immediately blocked and the error message:

  ERR 12 kV-MAX, is displayed.

- I TU > I TU-MAX. As soon as this error occurs, the inverter is immediately blocked and the error message:

  ERR 13 I-MAX, is displayed.

- If the exposure is prematurely interrupted manually, the error:

  ERR 18 exposure not ended, is displayed.

Refer also to the service instructions, chapter 3.

The entire document was restructured and revised.

SIEMENS-Getafe / Casero
TD SP 2 / Friedrich
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